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BCH 214(BIOENERGETICS)

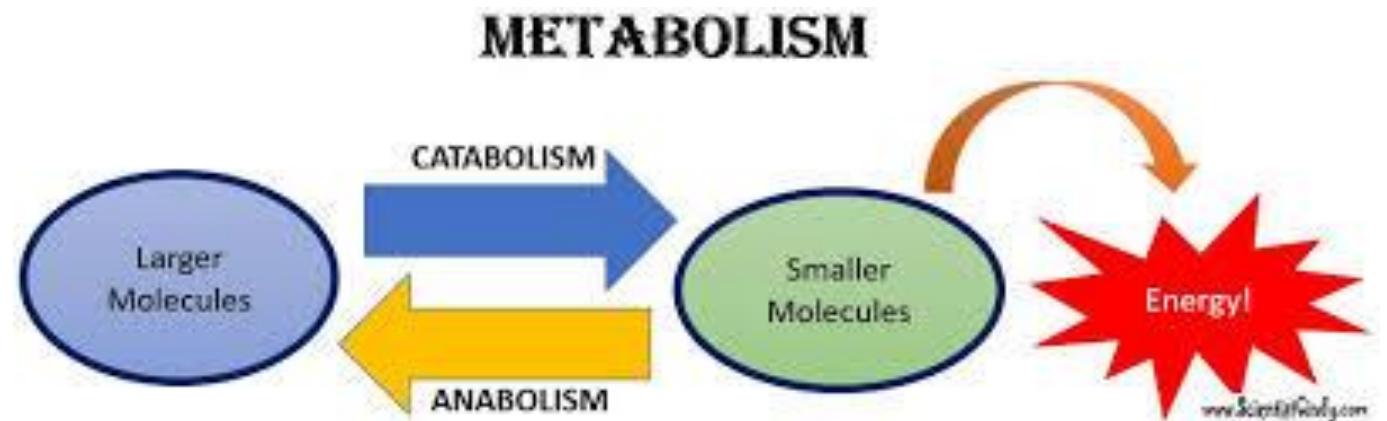
TOPIC: Energy Coupling

By

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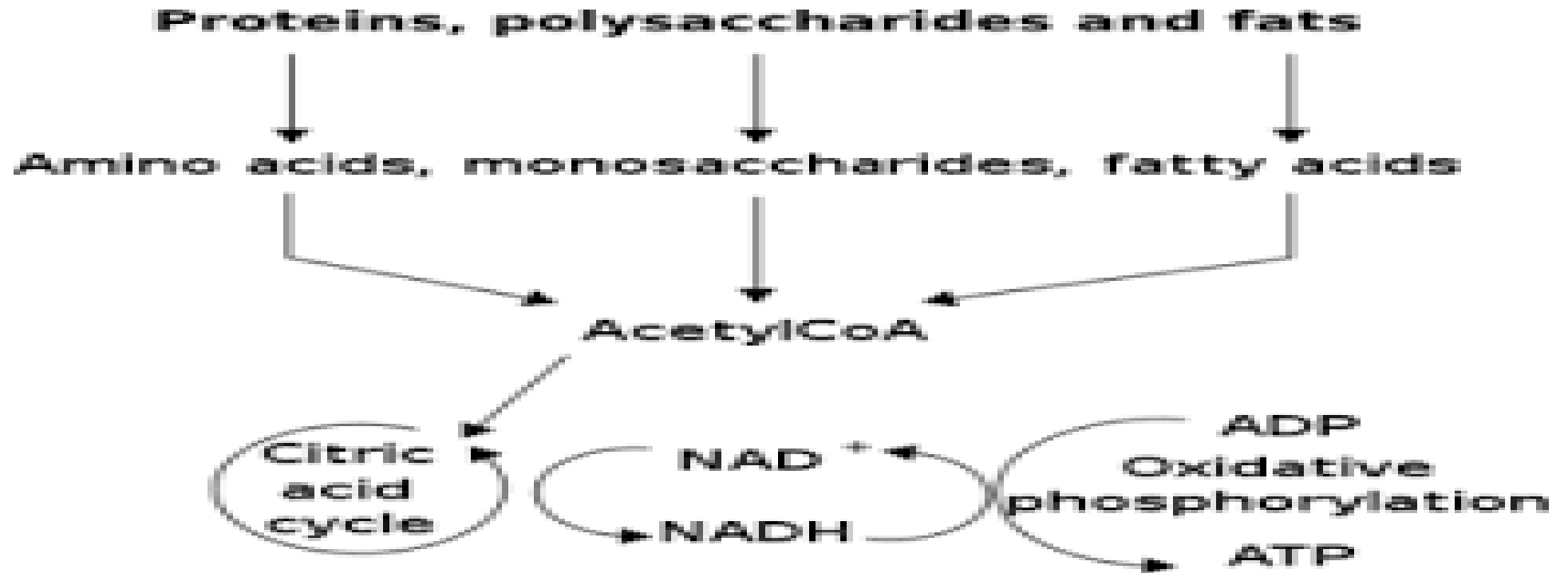
# Concept of Energy Coupling in Metabolism

- Introduction:
- Metabolism- sum total of biochemical reactions in an organism;
- Two categories
  - Catabolism
  - Anabolism



# Catabolism

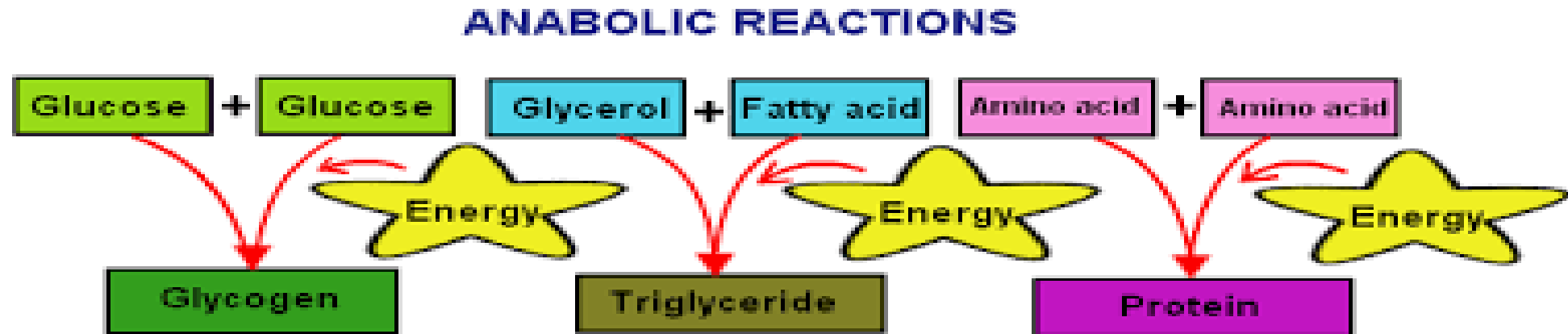
- Breakdown of complex biochemical metabolites
- Example:



- Characteristic of Catabolic reactions
  - Release free energy inherent in the biochemical molecule

# Anabolism

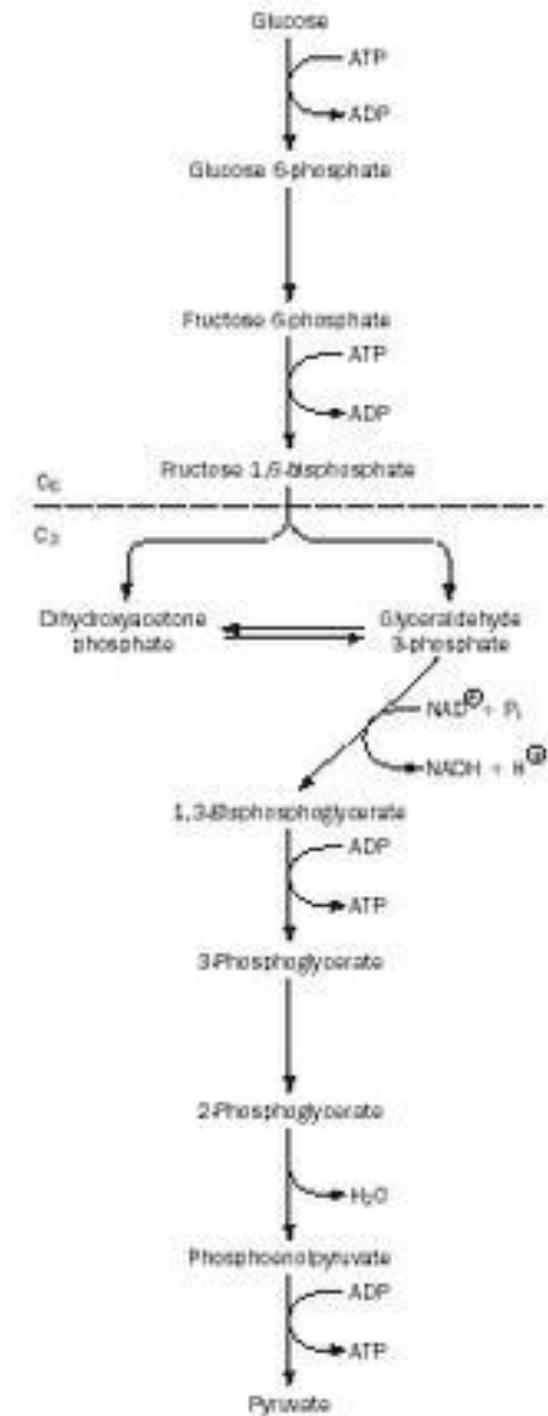
- The reverse of catabolism
- Entails build up of complex molecules from simpler units



- Common feature of Anabolic reactions:
  - Energy requiring

# Biochemical Pathway:

- Series of reactions catalyzed by enzymes converting a substrate to product.
- Not all reactions of a biochemical pathway are thermodynamically favourable/spontaneous



# QUESTIONS???

- Where does this energy come from?
- What about the economics of cellular processes?
- How best can the energy supply process be incorporated?

# Biochemical Energy Sources

1. High energy bonds
2. Redox potential

MSJ Chem  
Tutorials for IB Chemistry

**Cell potential and Gibbs free energy**

$$\Delta G^\ominus = -nFE^\ominus_{\text{cell}}$$

**n = moles of electrons transferred in the reaction**

**F = Faraday constant (96500 C mol<sup>-1</sup>)**

<b>E°</b>	<b>ΔG°</b>	<b>spontaneity</b>
positive	negative	spontaneous reaction
negative	positive	non-spontaneous reaction
zero	zero	reaction is at equilibrium

# Coupling !

- Definition:
- Connecting two things so they move/work together

Example





# Coupling in Bioenergetics

- In lay terms: an association of an energy releasing process to an energy requiring process.

$\Delta G^{\circ'}$  = Standard  
free energy change

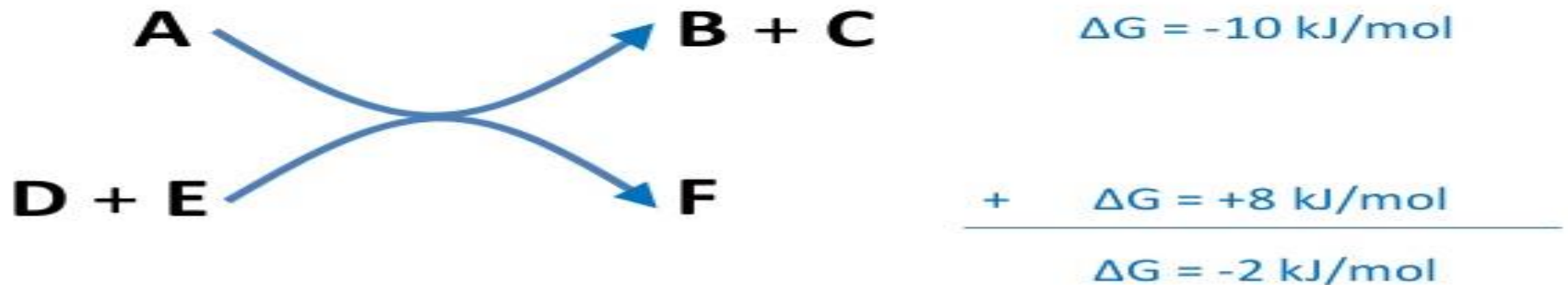
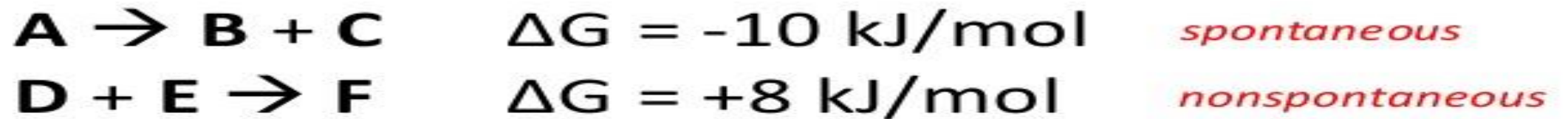
- Recall:
- $\Delta G^{\circ'}$  of a reaction is additive
- ie: if two biochemical reactions occur together, the total  $\Delta G^{\circ'}$  can be described thus;
  - Total  $\Delta G^{\circ'} = \Delta G^{\circ'}_1 + \Delta G^{\circ'}_2 \dots$

# Coupling in Bioenergetics *Contd'*

- In Biochemical terms:

## COUPLED REACTIONS

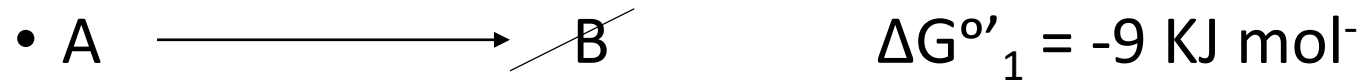
Ex.1:



When combined, the coupled reactions have a net negative  $\Delta G$ , so both reactions can occur spontaneously

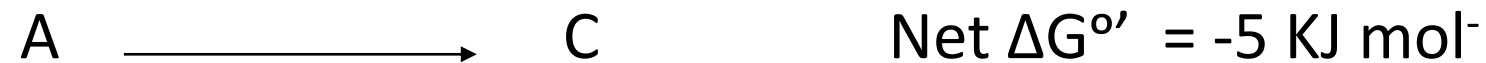
## Example 2:

- Consider the following:



The intermediate B can be eliminated

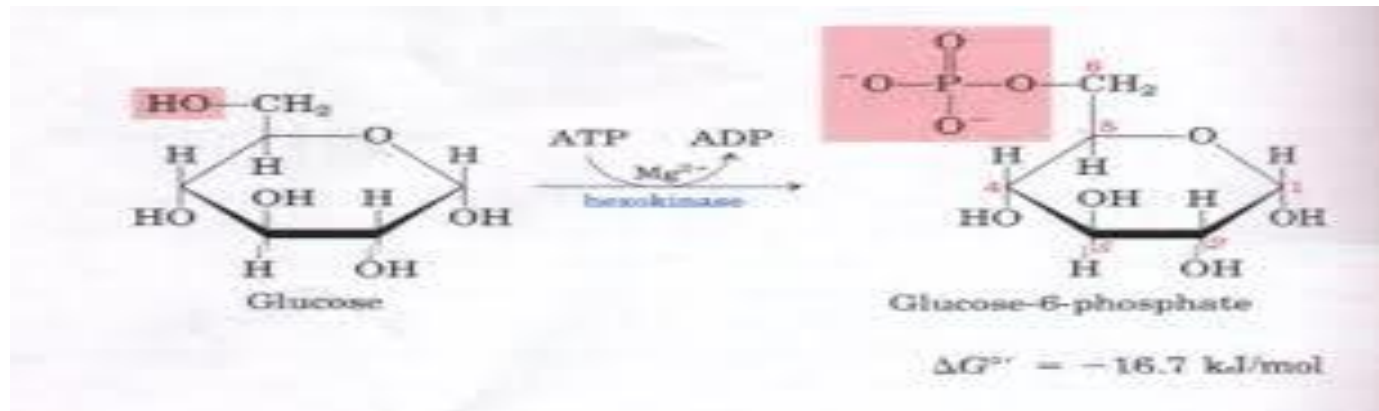
Overall reaction:



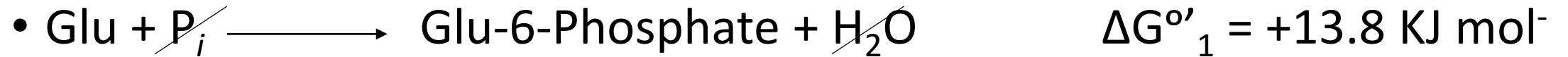
The overall reaction proceeds in the forward direction

# Typical Example: Phosphorylation of glucose

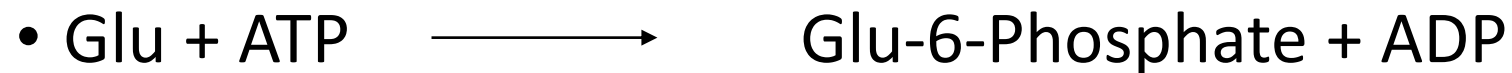
- This is an important biochemical process
- The direct incorporation of  $P_i$  into is not thermodynamically favourable
- The reaction is coupled with the high phosphoryl group transfer potential of ATP



# Phosphorylation of Glucose.



• Overall Reaction:



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• Total  $\Delta G^{\circ\prime} = -16.7 \text{ KJ mol}^{-1}$